

ABRIEF *not paper*
INTRODUCTION
TO
GEOGRAPHY
CONTAINING
A DESCRIPTION
OF THE
Grounds and General Part thereof.

Very necessary for young Students in that Science.

The Fifth Edition

Written by that Learned Man, Mr. *William Pemble*,
M. A. Of *Magdalen Hall* in OXFORD,
(Pemble)

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TO THE
READER.

GEntle Reader; I here present unto thy view these few sheets, written by that Learned man Mr. WILLIAM PEMBLE, I doubt not to call him the Father, the Child favours him so much. It hath long lain hid from thy sight, but now at length emboldned upon thy courteous acceptance of his former labours, it looks abroad into the World: It is but little, let not that detract any thing from it, there may lie much, though pen'd up in a narrow room; when thou reade'st, then judge of it: Thus much may be said; Though many have writ of this subject, yet this inferiour to none; thou maist observe in it an admirable mixture of Art and delight, so that for younger Student it may be their Introduction, for others a Remembrancer, for any not unworthy the perusal: only, let it find kind entertainment at thy hands. Farewell.

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A

BRIEF INTRODUCTION

TO

GEOGRAPHY.

CHAP. I.

A general description and division of Geography.

TOPOGRAPHIE is a particular description of some small quantity of Land, such as Landmeasures for out in their plots.

Chorography is a particular description of some Country, as of *England*, *France* or any Shire or Province in them, as in the usual and ordinary Map.

Geographie is an Art or Science teaching us the general description of the whole Earth, of this especially we are now to speak of, and also Chorography as a part under it contained; both excellent parts of knowledge in themselves, and affording much profit and help in the understanding of History and other things. The parts of Geography are two.

General, which treateth of the nature, qualities, measure, with other general properties of the Earth.

Special, wherein the several countries and coasts of the Earth are divided and described.

Of the general in the first place and more at large then of the other, because it is more difficult and hard to be understood, and

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and yet of necessary use, for the understanding of the other. This general tract may be parted into five particular heads.

1. Of the properties and affections of the Earth.
 2. Of the parts of it in general.
 3. Of the Circles of it.
 4. Of the distinction and division of it according to some general conditions and qualities of it.
 5. Of the measuring of it.
- These in their order.

CHAP. I.

Of certain general properties of the Earth.

IN Geography, when we name the Earth, we mean not the Earth taken severally by it self, without the seas and waters. But under one name both are comprised, as they are now mingled one with another, and do both together make up one entire and round body. Neither do we dive into the bowels of the Earth, and enter into consideration of the nature qualities, which are in the substance of Earth and Water, as coldness, dryness, moisture, heaviness, and the like: but we look only upon the outside, contemplating the greatness, situation, distances, measuring, and other such affections which appear in the superficies of it, to the eyes of our bodies and minds: These then of the Earth and Water together, rules are to be known.

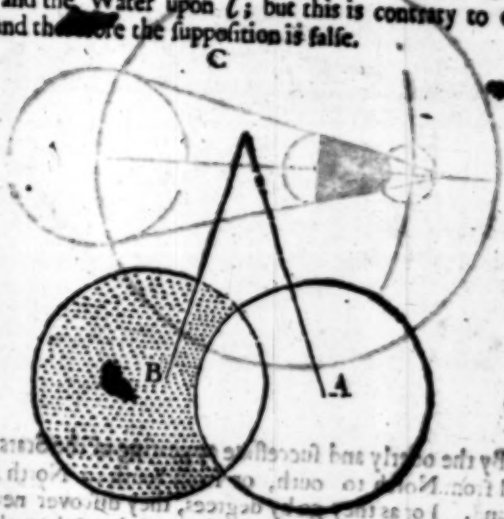
The Earth and the Water do make one Globe, i. e. one round or spherical body.

The natural place of the Water is to be above the Earth, and so it was in the first creation of it, compassing the Earth round about, as appears *Gen. 1. 9.* But for the use of man and all other living creatures, God made a separation of them, causing the water to sink down into huge hollow channells, prepared to receive it, that so the drie land might appear above it. Notwithstanding which separation, they do both still remain together, not covering one another as at first, but intermingled one with another, and that so exactly as they now make but one round body, whereas at first they made two. Here therefore are two points to be proved: 1. That they are one Globe. 2. That is one is round.

1. They

1. They are one Globe, having the same Center or middle point, and the same surface or convex superficies; which will appear by these reasons.

1. Common experience. Take a lump of Earth and any quantity of Water, and let them both fall down together upon the Earth from some high place, we see that in the descent they do not sever, but keep still together in one straight line, which could not be, if the Earth and Water were two several round bodies, having several centers. As for example, suppose them to be two Globes, and let *A* be the center of the Earth, and *B* the center of the Water; from *C* some high place above the Earth, hurl down Earth and Water, I say the Earth will part from the Water in going down, and the Earth will fall down upon *D*, and the Water upon *E*; but this is contrary to experience, and therefore the supposition is false.

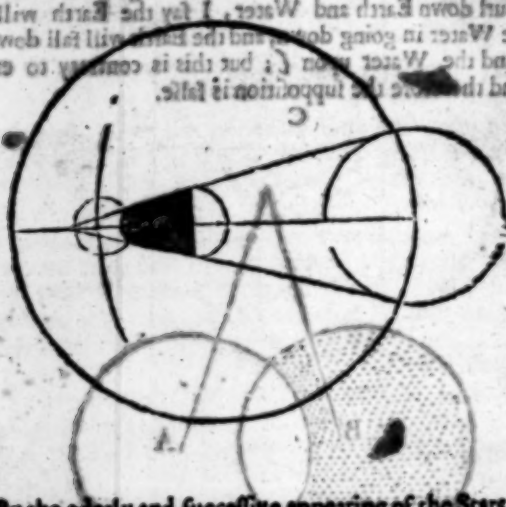


2. The shadow which in Eclipses is cast upon the Moon by the Earth and the Water, is but one and not two, and therefore the body is so likewise. This will appear in the proof of the next point. v. 2.

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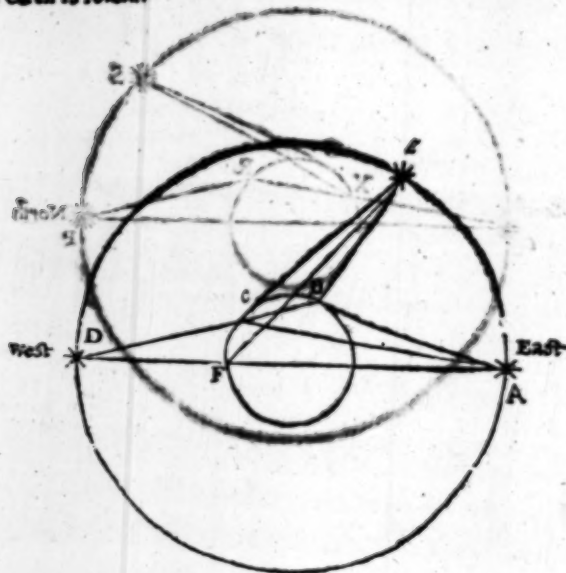
2. That both earth and water are one round body, not square, long, hollow, or of any other figure. This is proved by diverse reasons.

1. By Eclipses, when the earth-stands just between the Sun and the Moon, then doth the shadow of the earth falling upon the Moon darken it wholly or in part. Now as is the fashion of the shadow, such is the figure of the body, whence it falls, but the shadow of the earth and water cast upon the Moon is round, and also one; therefore they are round and also one body.



2. By the orderly and successive appearing of the Stars, as men travel from North to South, or from South to North, by Sea or Land. For as they go by degrees, they discover new Stars, which they saw not before; and lose the sight of them they did, which could not be if the earth were not round. As for example, let XOR , the inward Circle be the earth, QSP , the outward the Heaven: they cannot see the Star S which dwell upon the earth in X , but if they go Northward unto O they may see it. If they go farther to R they may see the Star P , but then they lose the sight the of the star Q , which being at X and

from East to West, let *A* be the Sun, or a Star. When the Sun *A* is up, and shines upon them that dwell in *B*, he is not risen to them that dwell in *C*. Again, when he is risen higher, and is come to *E*, and so shines upon those that dwell in *C*, he is not yet up to them that dwell in *F*. Again, when he sets in the West in *D*, and so is out of sight to the inhabitants in *B*, he is yet up to them that dwell in *C* and *F*: Which shews plainly the earth is round.

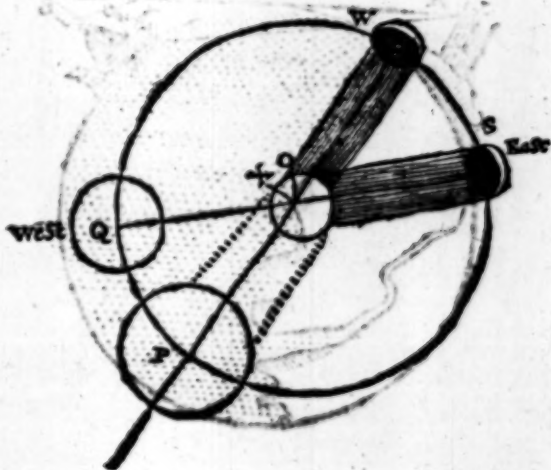


By the different observations of Eclipses. One and the same Eclipse appearing sooner to the Easterly Nations then those that lye farther West; which is caused by the bulke of the earth swelling up between, As for example.

Let

TO GEOGRAPHIE.

Let XO be the Circle of the earth, and the greater the Circle of the heaven from East to West. Let PQ be the body of the Sun, WS of the Moon in the eclipse, by reason of the earth between it and the Sun. It is manifest that the inhabitants in O shall see the eclipse before the inhabitants in X by certain hours, according as the distance between X and O is more or less. They that dwell in O shall see it in S ; they that dwell in X see it not till it come to W , a great deal higher.



mountains by leaving the ground at the bottom of the
mountains of the sun and water; it is not to be feared.

5. That the water is round besides the natural weight and moisture of it, which being apt to yield and run abroad, will not suffer some places to lye high, and some low, like hills, and dales, but though it be made rough and uneven by tempests, doth presently return to their natural smoothness and evenness: I say besides this, it is close by common experience: for if we stand on the

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land, and see a ship go forth to sea, by degrees we lose the sight of it, first of the hull, then of the mast and all. So also on the other side, they that are at Sea, by degrees do lose or gain the sight of the Land: As for example,

Let *A* be some steeple on the land, *B* a ship at sea: He that stands at *A* shall by little and little lose the sight of the ship as she goes out, and get sight of her as she comes in. Both first and last he shall have the sight of the top-mast *B*, when he sees nothing else; because the sea riseth up between his sight and the ship.



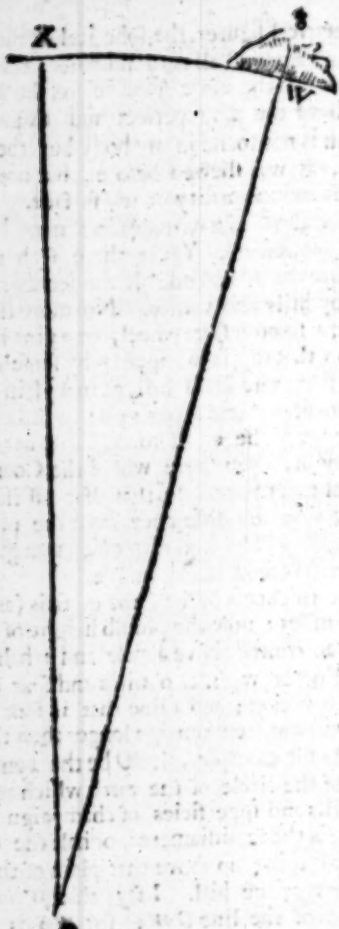
These reasons and experiments may suffice to prove the roundness of the earth and water; which might be further demonstrated by shewing the falshood of all other figures regular or irregular that can be given unto it: that it is neither square, nor three corner'd, nor Pyramidical, nor Conical or Taperwise, nor Cylindrical like a barley rowle, nor hollow like a tube, nor of any other fashion, as some have imagin'd it to be. We come to this second rule.

2. The tops of the highest hills, and barrowes, shew most evidently, although in several places they make the same appearance, yet being com-

pared to the vast greatness of the whole, do not at all hinder the roundness of it.

Among all Geometrical figures, the spherical or the round is the most perfect; and amongst all natural bodies, the heaven is the most excellent. It was therefore good reason the most beautiful body should have the most perfect and exquisite shape. Exact roundness then is not found in any body but the Heaven; the earth is round, as was shewed before, but not precisely, without all roughness and inequality of its surface. There are hills like warts, and vallies like wrinkles in a mans body, and that both for ornament and use. Yet is there such uniformity in this variety, as that there is no notable and sensible inequality made in the earth by hills and vallies. No more then if you should lay a fly upon a smooth Cart wheel, or a pins head upon a great Globe. Now that this is so, appears by sense and reason. By sense thus, If we stand on a small hill, or in a plain, whence we may descry the country round about 15 or 20 miles; we may behold the brim or edge of the earth round about us to be in a manner even and straight, even there where the Country is very hilly, and full of mountains. So that as far off their height makes but little alteration and difference from the plain countries, when we behold altogether as far off; though when we come near, the alteration seems more sensible.

By reason thus, the thickness of half the earth is (as shall be shewed) about 4000 miles: now the plumb height of the highest mountains is not accounted above a mile and a half, or two miles at the most. Now between two miles and four thousand, there is no sensible proportion; and a line that is four thousand and two miles long, will not seem sensible longer then that which is four thousand. As for example, let O be the center of the earth; XW a part of the circle of the earth which runneth by the bottoms of the hills and superficies of champaign and even plains; WO , or XO , is the semidiameter, or half the depth of the earth; S is a hill rising up above that plain of the earth; WS is the plumb height of the hill. I say, that WS doth not sensibly alter the length of the line OW ; for WS is but two miles, WO 4000 miles; and two to 4000 alters not much more, then the breadth of a pin to the length of a pearch. So a line drawn from O the center, to S the top of the hill, is in a manner all one with a line drawn to W , the bottom of the hill.



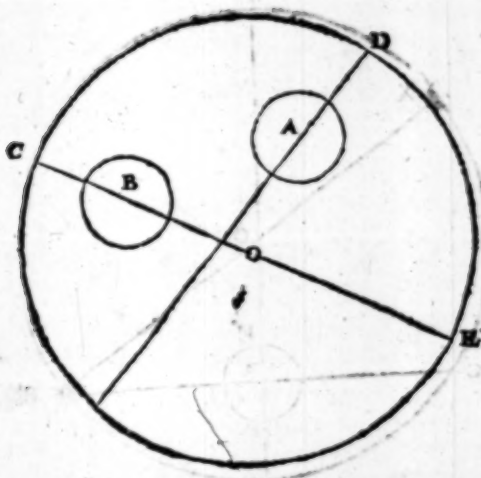
The third Rule.

3. The earth resteth immovable in the very midst of the whole World.

Two points are here to be demonstrated, *First, that the earth standeth exactly in the midst of the world. Secondly, that it is immovable.* The former is proved by these reasons.

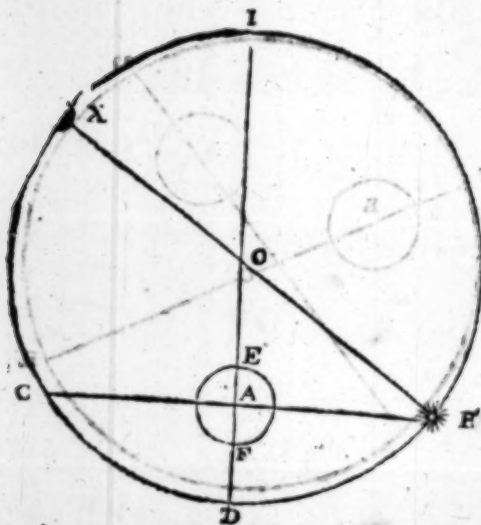
1. The natural heaviness of the earth and water is such, as they will never cease moving downwards 'till they come to the lowest place; Now the center or middle point of the world is the lowest place, and therefore they must needs move thither. As for example:

Let *O* be the center of the World, *CDE* the Heavens: it is manifest that the lowest place from the Heavens on all sides is *O*. Suppose the Earth to be in *A*, or in *B*, some where out of the center, I say it is not possible (unless it be violently held up) that it should abide there, but it will descend till it come to *O*, the middle point.



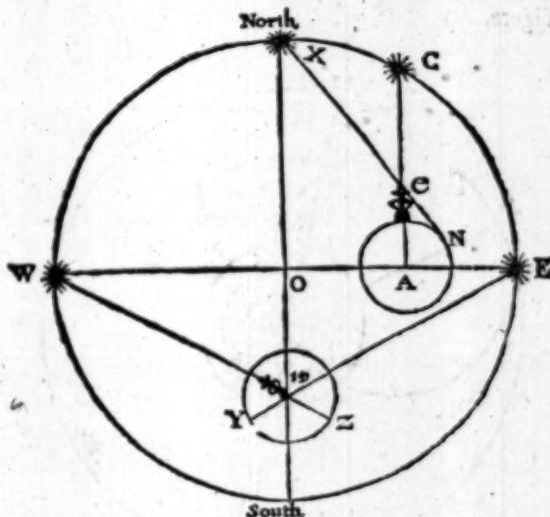
2. If the earth stood any where but in the midst, we should not see half the heavens above us, as now we alway do, neither could

could there be any Equinox ; neither would the daies and nights lengthen and shorten in that due order and proportion in all places of the world as now they do. Again, Eclipses would never fall out but in one part of the Heavens ; yea, the Sun and Moon might be directly opposite one to another and yet no Eclipse follow ; all which are absurd. As for example, let the center of the world be *O*, let the earth stand in *A*, a good way distant from the center ; it is manifest that the greater half of the heavens *CIB* will alwaies be above, and the lesser half *CDB* below, which is contrary to experience. Thence also it follows that the daies and nights will never be equal ; for the Sun *B* will be alwaies longer above the earth whilst he moves from *B* to *C*, then below moving from *C* to *B*. Again, the Sun *B*, may stand just opposite to the Moon *X*, and yet no Eclipse follow, the earth which makes the Eclipse standing out of the midst.



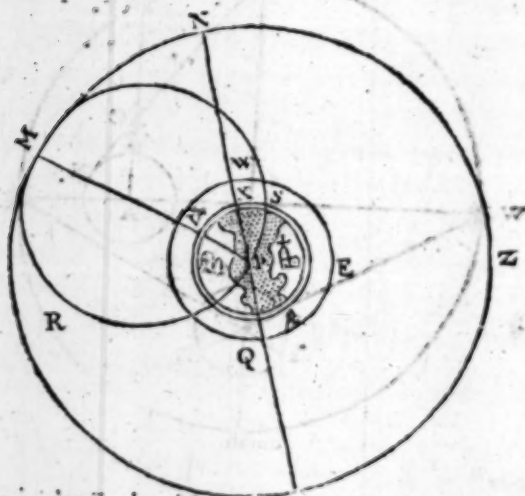
showing, that the earth is not in the midst of the world, as now we are taught, but that it is above the world, as now we are taught.

3. The shadows of all Bodies on the Earth would not fall into that orderly uniformity as they do ; for if the Earth stood towards the East, the shadows would be shortest before noon ; if toward the West, after noon ; if towards the North, the shadows would still fall Northward ; if towards the South, Southwards : all which experience shews to be false. As for example, let the Earth stand Eastwards in *A*, the shadow of any Body upon the Earth, as of the Body under *E*, will be shorter in the morning when the Sun is in *C*, than at noon when the Sun is in *X*. If the Earth stand Southward in *W*, the shadow of any Body will alwaies fall South, as it doth in the Figure *T* and *Z*.



The second thing to be proved was, That the Earth is immovable. Where we must understand a double motion, Streight or Circular. For the first it is clear, that without supernatural violence it cannot be moved in any streight motion ; that is, upward, downward, or toward any side : it cannot be shoved out of his place.

For the second, whether abiding still in his place it may not move round, the question is disputed; and maintained on both sides. Some affirm it may and doth; who think there is greater probability the Earth should move round once a day, than that the Heavens should, by reason of the incredible swiftness of the Heavens motion, scarce compatible to any natural body; and the more likely slowness of the Earths moving. Others deny it, grounding their opinion upon Scripture, which affirms the Earth to stand fast, so as it cannot be moved; and upon Sense, because we perceive it not to move; and lastly, upon Reasons drawn from things hurled up, and let fall upon the Earth. The Arguments on both sides will be more easie to be understood by this Figure.



In this Figure it is manifest that the Earth in the midst cannot move by any streight motion; upward toward *N*, or side-ward toward *M*, or any other way out of its proper place; and therefore that opinion of *Copernicus* and others, that the Earth should

should move round once a year in such a Circle as *M P R*, is most improbable and unreasonable; and rejected by the most.

But although it cannot move streight, it may move round. For though it be a marvellous great body of unconceivable weight, yet being equally poised on every side, there is nothing can hinder its circular motion: as in a Globe of lead, or any other heavy substance, though it were forty Fathom in compass, yet being set upon his two Poles, it would easily be turned round, even with the touch of ones little finger. And therefore it is concluded that this circular motion is not impossible. The probability of it is thus made plain: The whole circuit of the Heavens, wherein are the fixed Stars, is reckoned by Astronomers to be 1017562500, that is, a thousand and seventeen millions of miles, five hundred sixty two thousand, and five hundred miles. Let this be the compass of the Circle, *N M O Z*. So many miles do the heavens move in one day, till the same point come to the place from whence it went; as till *N* move round, and come to *N* again. This being the motion of the whole day 24 hours, how many miles will *N* move in one hour? it will move 42398437 and a half, i. e. forty two millions, three hundred ninety eight thousand, four hundred thirty seven miles and a half. So many miles will *N* move in one hour, from *N* to *M*. A motion so swift, that it is utterly incredible. Far more likely it is, the circuit of the earth *A S X V* being about 24000, i. e. twenty four thousand miles more or less, it should move round once a day. For then one point, as *X*, should move in one hour from *X* to *V*, but a thousand miles; which motion although it be swifter then any arrow, or bullet from a Canons mouth, yet it is incomparably slower then that of the heavens, where so many millions are passed over in an hour.

10644609.9

10 mile in
a minute.

Now for the salving of all the celestial Phenomina, or appearances, the truth is the same, if we suppose the earth to move, as if we believe it to stand still. The rising of the Sun and Stars, the motions of all the Planets, will keep correspondence as now. Nor need we fear jogging, or that steeples and towers would totter down, for the motion is regular and steady, without rube and knocks. As if you turn a Globe round, it will go steadily, and a flie will sit fast upon it, though you move it apace. Besides, the

whole Body, the Air, is carried about with the whirling of the Earth; so that the Earth will make no wind as it turns swiftly about, as a Wheel will if it be turned apace.

Notwithstanding all this, most are of another opinion, that the Earth standeth still without all motion, rest rather befitting so heavy and dull a body then motion. The main reason brought to establish it is this; Let a Stone be thrown down out of the Air from *W*, if the Earth stand still, it is manifest it will fall upon *X* just under it; as we see it doth. By common experience, a stone will fall down from any height upon the place we aimed at; but let the earth move, the stone will not light upon *X*, but somewhere else, as on *S*; for *X* will be moved away, and gone to *P*.

So again, let two pieces of Ordnance (that will shoot at equal distance) be discharged, one just towards the East, the other towards the West; if the Earth move (as they say it doth) towards the West, the Bullet that is discharged Eastward, will flie farther than that Westward: for by the contrary motion of the earth he will gain ground. But experience hath proved this to be false, shewing that the Bullets will both flie at equal distance.

To save this, answer is made, that the earth by its swift motion carries with it (and steadily) not only all bodies resting or moving upon it, but also the whole Sphere of Air *WEQ*, with all things whatsoever that are moved in it naturally or violently, as Clouds, Birds, Stones hurled up or down, Arrows, Bullets, and such like things violently shot forth; as may appear in the Figure.

The Fourth Rule.

4. The earth, though it be of exceeding great quantity being considered in it self, yet being compared to the heavens, especially the higher spheres, is of no notable bigness, but may be accounted as a point or prick in the midst of the world.

That the earth is no bigger than a point or pins head in comparison of the highest heavens, will easily appear unto us by these reasons.

1. The Stars, which are many times bigger then the earth, seem yet to us to be no bigger then a great pins head; or such like

if we observe the height of the Star *S* above the Horizon *B E*, it will be all one; namely, *BS* whether we observe it in the top of the Earth in *A*, or in the middle in *O*. For *A* and *O* are so little distant one from another, that *AS* and *OS* will be parallel lines, and be esteemed but as one line. The fourth reason concerning Dials, is clear by the framing and construction of them; wherein either the lower end of the Cock (or Gnomon) whereat all the hour-lines meet, or the upper end and knob (as in many Dials) is supposed to be the Center of the Earth.

C H A P. III.

Of the parts of the Terrestrial Globe.

THe properties of the earthly Globe have been handled in the former Chapter, we come now to the parts, which are two in general:

{ Earth } Both contain under them more particular
 { Water } parts to be known.

The more notable parts of the Earth are these.

1. A Continent, or main Land; or as some called it, firm Land, which is not parted by the Sea running between.
2. An Island, a Land compassed about with Waters.
3. A Peninsula, a Land almost surrounded by Waters save at one place, where it joyns by a narrow neck of Land to the Continent; this is also called Chersonesus.
4. An Isthmus, a streight neck of Land which joyns two Countries together, and keeps the Sea from compassing the one.
5. A Promontory, or Head-land running far out into the Sea like a wedge.
6. A Mountain,
7. A Valley,
8. A Champion-plain,
9. A Wood.

} All easie to be known without
 any definition.

The more notable parts of the Water are these:

1. *Mare*, the Sea or Ocean, which is the gathering together of all Waters.
2. *Fretum*, a streight or narrow Sea running between two Lands.
3. *Sinus*, a Creeke, Gulf or Bay, when the Sea runs up into the bosome of the Land by a narrow entrance, but openeth it broader

broaden when it is within : if it be very little, it is called a Haven, *Portus*.

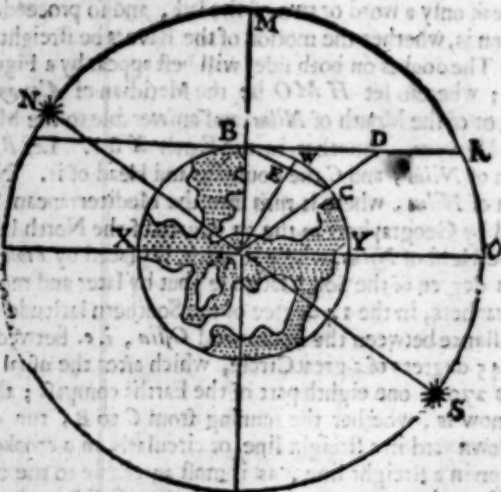
4. *Lacus*, a Lake, a little Sea within the Land having Rivers turning into it, or out of it, or both. If it hath neither, it is called *Stagnum*, a standing Pool ; also *Palus*, a Fen.

5. *Fluvius*, a River : which from the pleasantness is also called *Amnis* ; from the smallness of it, *Rivus*.

Now concerning these parts, divers Questions are moved : whether there may be more Sea or Land ; whether the Sea would naturally overflow the Land, as it did in the first creation, were it not withheld within his Banks by Divine power ; whether the deepness of the Sea doth exceed the height of the Mountains ; whether Mountains were before the Flood ; what is the height of the highest Hills ; whether Islands came since the Flood ; what is the cause of the Ebbing and Flowing of the Sea ; what is the original of Springs and Rivers ; what manner of motion the running of the Rivers is ; with such like, whereof some belong not so properly to this Science of Geography as to others. We speak only a word or two of the last, and so proceed. The Question is, whether the motion of the Rivers be streight or circular ? The doubts on both sides will best appear by a Figure first drawn ; wherein let *HMO* be the Meridian of *Alexandria* in *Egypt*, or of the Mouth of *Nilus*, and answerable to the Meridian of the Heavens. Another in the Earth *XYZ*. Let *B* be the Mouth of *Nilus*, and *C* the Fountain and Head of it. Now the Mouth of *Nilus*, where it runs into the Mediterranean Sea, is placed by Geographers in the 31 degree of the North latitude ; and the Head of *Nilus*, where it riseth, is placed by *Ptolemy* in the 11 degree of the South latitude ; but by later and more exact Geographers, in the 14 degree of the Southern latitude ; so that the distance between the Founts and *Ofis*, i. e. between *C* and *B*, is 45 degrees of a great Circle, which after the usual account makes 2700, one eighth part of the Earths compass ; the Question now is, whether the running from *C* to *B*, run continually downward in a streight line, or circularly in a crooked line ? If it run in a streight line, as is most agreeable to the nature of the Water, it must move either by the line *CEB*, or by the line *DB*. By the line *CEB* it cannot move ; for when it comes to *E* it will stand still : because from *E* to *B* it must move upward if it

move

move at all, which is contrary to the nature of water. If therefore it move by a straight line, it can be no other but BD , and so from B to D it shall continually descend; for of all places between D and B , B is the nearest to A : but then the fountain must not be in B , but higher in D , which seems altogether improbable or impossible; for first, the line AD would be notable, and sensibly longer than the line AB . For the compass of the earth being about 2400 miles, and the semidiameter AB or AC , 3828 miles, the line CD would be 1581 miles, which cannot be true, if (as we have proved before) the earth be round, and that the highest hills make no sensible inequality. Again, they that dwell in D should see the North-Pole-Star N , as well as they that dwell in B , which also is false. So then the river cannot run either by EB or DB ; runs it then circularly by the line CB ? This seems probable; and the rather, because hereby a reason of the original of rivers might more easily be



given. For the fountain C lying even with the superficies of the

the sea, the water may easily pass through the hollows of the earth, and break out at *C* without ascending. But here also are some difficulties; for first, we find by experience that the fountains of most rivers, and those great ones too, lie sensibly higher than the plain surface of the sea. Again, if the river move directly round, what should be the cause that begins and continues this motion? It is a motion besides the nature of the water, and therefore violent, what should drive it forward from the sea to *C*, and from *C* to *B*? When the water is at *C*, or *W*, it is as near to the center *A*, as when it is at *B*; and therefore it should seem with more likelihood it would stand still; for why should it strive to go further, seeing where it is, it is as near to the center as whither it runs? Or if some violence do drive it from *C* towards *W*, yet (as it is the nature of violent motions) the farther it goes, the slower it will run, till in the end it stand still, if there be no advantage of ground to help it forward.

As a bowle thrown down a hill runs easily and far if it once be set a going; but thrown upon the ice (an even place) it will without any let at last stand still. Answer may be made hereunto, that although there be no advantage of the ground, yet the water will still move forward from *C* to *B*, because the water that follows, pusheth forward that which runs afore; which answer will stand, when a good cause may be shewed, which forcibly driveth the water from the sea unto *C*, and out of the fountain *C*; considering that (after this supposition) they lie both in the same circular superficies. Wherefore seeing we cannot without any inconveniency suppose it to move by any of these lines, either streight, as *BC*, or *BD*, or circular, as *BWC*, let us enquire farther.

The most likely opinion is, that the motion of the water is mixt, neither directly streight, or circular, but partly one, partly the other. Or if it be circular, it is in a circle whose center is a little distant from the center of the whole Globe. Let us place fountains then neither in *C* nor *D*, but in *F*, I say, the water runs either partly streight by the *FS*, and partly circular from *S* to *B*; which motion will not be inconvenient, for the water descending continually from *F* to *S*, will cause it still to run forward, or else wholly circular in the circle *FXB*. And this is most

fountain stand above the mouth, and the surface of the plain hand, (for rivers commonly arise at the feet of hills) which is *BXF*, swell up above the surface of the sea *BWC*, or *BT*; which height of the land above the sea, although it be greater then is the height of the highest mountains above the plain land, yet it is nothing in comparison of the whole earth. And this being granted, (as with more probability of reason it may) it will appear, that God in the beginning of the World imposed no perpetual violence upon Nature, in gathering together the Waters into one place, and being so gathered, in keeping them from running back to cover the Earth. At the first, so soon as those hollow Channels were prepared, the Water did naturally slide down into them, and out of them without miraculous power they cannot return. For if the sea *BT* should overflow the land towards *F*, the water must tend in running from *B* to *F*, which is contrary to its nature. Certainly the mid-land Countries, whence Springs of great rivers usually arise, do lie so high that the sea cannot naturally overflow them. For as for that opinion, that the water of the sea in the middle lies on a head higher than the water that is by the shore, and so that it is a harder matter to sail out of a Haven to sea-ward, than to come in, (because they go upward) is an empty speculation, contrary to experience, and the grounds of Nature it self, as might easily be shewed: All the difficulty that is in this opinion, is to give a reason how the waters mount up to *F*, and whence the water comes that should flow out of so high a place of the earth; wherein I think, as in many other secrets of Nature, we must content our selves with ignorance, seeing so many vain conjectures have taken no better success.

CHAP. IV.

Of the Circles of the Earth.

IN a round body, as the earth is, there can be no distinction of parts and places without the help of some lines drawn, or imagined to be drawn upon it. Now there are not, nor can be any circles truly drawn upon the earth; yet because there is a good

D a

Ground

ground in Nature and Reason of things from them, we must imagine them to be drawn upon the earth, as truly as we see them described upon a Globe, or in a plain Paper. Farther this must be noted, that all circles on the earth have the like opposite unto them conceived to be in the heavens, under which they are directly situated. This known, the circles that we are to take the special notice of are of two sorts, greater and lesser.

The greater circles are those which divide this earthly Globe into equal halves, or Hemispheres.

The lesser are those which divide it into two unequal parts, one bigger, another lesser.

Of the former sort there are four, the

1. Equator.

2. Meridian.

3. Horizon.

4. Zodiack, or Ecliptick.

1. *The Equator, or Equinoctial-line, is a line drawn just in the midst of the earth, from East to West, which compasseth it as a girdle doth a mans body, and divideth it into two equal parts, one on the North-side, the other on the South. The two points in the earth that are every way farthest distant from it North and South, are called the Poles of the Earth; which do directly stand under the two like points in the Heaven; so called because the Heaven turns about upon them, & the earth doth in a Globe that is set in a frame. This circle is of the first and principal note and use in Geography, because all measurings for distances of places and quarters of the earth are reckoned in it, or from it. It is called the Equinoctial, because when the Sun in the Heavens comes to be directly over that circle in the Earth, the daies and nights are of equal length in all parts of the World; Mariners call it by a-kind of excellency, *The Line*. Upon the Globe it is easily discerned, being drawn bigger than any other circles from East to West, and with small divisions.*

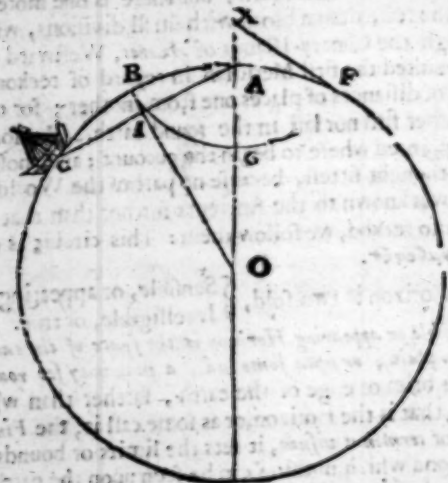
2. *The Meridian is a line that is drawn quite cross the Equinoctial, and passeth through the Poles of the Earth, going directly North and South. It is called the Meridian, because when the Sun stands just over that circle, it is Meridies, i. e. Noon-day. It may be conceived thus; At noon-day, when it is just twelve a clock, turn your face toward the South, and then imagine with your self two circles drawn, one in the Heavens, passing from the North just over your head through the body of the Sun*

Sun down to the South, and so round under the Earth up again to the North-pole; another upon the surface of the Earth, passing through your feet just under the Sun, and so compassing the Earth round till it meet at your feet again, and these are Meridians answering one to another. Now the Meridian is not one only, (as was the Equinoctial) but many, still varying according to the place wherein you are: As for example, at *London* there is one Meridian, at *Oxford* another, at *Bristol* another, and so along Eastward or Westward; for it is noon at *London* sooner than at *Oxford*, and at *Oxford* sooner than at *Bristol*. Upon the Globe there are many drawn, all which pass through the Poles, and go North and South; but there is one more remarkable than the rest, drawn broad with small divisions, which runneth through the Canary-Islands of *Azores*, Westward of *Spain*, which is counted the first Meridian in regard of reckoning and measuring of distances of places one from another; for otherwise here is neither first nor last in the round earth. But some place must be appointed where to begin the account; and those Islands have been thought fittest, because no part of the World that lay Westward was known to the Ancients further than that; and as they began to reckon, we follow them: This circuit is called in Greek *Μεσημβριον*.

3. The Horizon is two-fold, { Sensible, or appearing.
 { Intelligible, or true.

*The sensible or appearing Horizon is the space of the earth so far as in an open plain, or upon some hill, a man may see round about him. The brim or edge of the earth, farther than which you cannot see, that is the Horizon, or as some call it, the Finis, because finis, or terminus visum, it sets the limits or bounds to your sight, beyond which nothing can be seen upon the earth. This is greater or lesser, according as the height of the eye above the plain superficies of the earth is more or less. The most exact trial hereof is at Sea, where there are no mountains, nor any unequal rising of the waters to hinder the sight, as there are at Land. For example, let *CB* *AE* be the superficies of the Sea, and let a mans eye be placed in *X*, above the Sea; as the eye stands higher or lower, so will the distance seen be more or less: as if the height of *X* be six foot, which is ordinary the height of a man, the eye looking from *X* to *B* shall see two miles and three quarters;*

quarters; if *X* be twenty foot high, *B A* will be five miles; if forty foot, seven miles; if fifty foot, eight miles. So that from the mast of a ship fifty foot high, a man may see round about at sea eight miles every way, toward *B G* and *F*; so far may the water it self be seen: But any high thing on the water may be seen farther, sixteen or twenty miles, according as the height is, as the ship at *C* may be seen from *X*, as far more as it is from *A* to *B*. There can be therefore no certain quantity and space set down for this sensible Horizon, which continually varies according to the height of the eye above the plain ground or sea. This Horizon is not at all painted on the Globe, nor can be.



The intelligible or true Horizon, is a line which girds the earth round in the midst, and divides it into two equal parts or Hemispheres; the uppermost, upon the top and middle point whereof we dwell, and that which is under us. Opposite to this in the Heavens is another Horizon, which likewise cuts the Heaven into two Hemispheres, the upper and the lower; above which circle, when any Star or the Sun is moved, it then riseth unto us, and setteth unto

unto those that dwell opposite unto us, and so on the contrary. You may conceive it best thus, if standing upon a hill, or some open place, where you may perfectly see the setting of the Sun, you mark when the Sun is half gone out of your sight, you may perceive the body of the Sun cut in two, as it were by a line going along through it, the half above it yet seen, that underneath is gone out of your sight. This line is but a piece of the Horizon, which if you conceive to be drawn upward about the World, from the West to the North, and by East and South to West again, you have the whole Horizon described.

This circle is not drawn upon the body of the Globe, because it is variable; but stands on the outside of it, being a broad circle of wood covered with paper, on which are set the months and daies of the year, both in the old and new Calender, and also the twelve signs, and the points of the compass; all which are easily discerned by the beholding. The use of this Horizon is not so much in Geography as in Astronomy.

The Zodiack is a circle which compasseth the earth like a belt, crossing the Equator slopewise, not straight as the Meridians do. Opposite to it in the heavens is another circle of the same name, wherein are the twelve signs, and in which the Sun keeps his own proper course all the year long, never declining from it on the one side or other. The use hereof in Geography is but little, only to shew what people they are over whose heads the Sun comes to be once or twice a year; who are all those that dwell within twenty three degrees of the Equator; for so much is the declination, or sloping of the Zodiack. This circle is also called the *Ecliptick-line*, because when the Sun and Moon stand both in this circle, opposite each to other, then there happens an Eclipse of the Sun or Moon; upon a Globe it is easily discerned, by the sloping of it from the Equator, and the divisions of it into twelve parts, and every of those twelve into thirty degrees.

These are the greater circles; the lesser follow; which are all of one nature, and are called by one general name: sc. Parallels, because they are so drawn on each side of the Equator, as they are equidistant unto it every way, (as is easie to be seen) and may be conceived to be drawn upon the earth; but there are only two sorts chiefly to be marked; namely the

1 Tropick, and the }
2 Polar Circles. }

The

The Tropicks are two parallel circles, distant on each side of the Equator twenty three degrees, shewing the farthest bounds of the Sun's declination North or South from the Equator, or of the middest of heaven. And therefore they are called Tropicks, a word so understood, because when the Sun comes over these lines, he either turns away from us, as in the summer; or turns towards us again, as in the winter. There are then two of them, viz.

1. The Tropick of Cancer, which lies on the North-side of the Equator, to which when the Sun comes, it makes the longest day in summer.
2. The Tropick of Capricorn, lying Southward of the Equator, to which when the Sun comes, it makes the shortest day in winter.

The Polar-circles are two parallels drawn by the Poles of the Zodiack, compassing about the Poles of the World, being distant from them every way twenty three degrees.

1. The Arctick-circle that compasseth about the North-pole. It is so called, because that in the Heavens (whereunto this in the Earth lies opposite) runs through the constellation of the great Bear, which in Greek is called *Arctos*.

2. The Antartick-circle that compasseth about the South-pole, and is placed opposite unto the former. All these with the former are easily known upon the Globe by these descriptions, and names usually added unto them: But because Maps are of an easier price, and more common use than Globes, it will be needfull to shew how all these circles, which are drawn most naturally upon a round Globe, may also as truly and profitably for knowledge and use be described upon a plain paper; whereby we shall understand the reason of those lines which we see in the usual Maps of the World, both how they are drawn, and wherefore they serve. Understand therefore, that in laying down the Globe upon a plain paper, you must imagine the Globe to be cut in two halves thorow the midst, and so to be pressed down flat to the paper; as if you should take a hollow dish, and with your hand squeeze the bottom down till it lie flat upon a board, or any other plain thing: for then will those circles that before were of equal distance, run closer together towards the midst. After this, conceive universal Maps are made of two fashions, according as the Globe may be divided two waies, either cutting

cutting quite through by the Meridian from North to South, as if you should cut an apple by the eye and the stalk, or cutting it through the Equinoctial, East and West, as one would divide an apple through the midst, between the eye and the stalk. The former makes two faces, hemispheres, the East and the West hemisphere, the latter makes likewise two hemispheres, the North and the South. Both suppositions are good, and befitting the nature of the Globe: for as touching such universal Maps wherein the world is represented not in two round faces, but all in one square plot, the ground whereupon such descriptions are founded, is less natural and agreeable to the Globe, for it supposeth the Earth to be like a Cylinder (or role of Bowling-alles;) which imagination, unless it be well qualified, is utterly fall, and makes all such Maps faulty in the situation of places. Wherefore omitting this, we will shew the description of the two former only, both which are easie to be done.

1. To describe an Equinoctial planisphere, draw a circle *ABCD* and inscribe in it two diameters *AB* and *CD* cutting each other at right angles, and the whole circle into four quadrants: each whereof divide into 90 parts or degrees. The line *AB* doth fully represent half of the Equator, as the line *CD* (in which the points *C* and *D* are of the two poles) half of the Meridian; for these circles, the eye being in perpendicular line from the point of concurrence, (as in this projection it is supposed) must needs appear straight. To draw the other, which will appear crooked, do thus. Lay a rule from the Pole *C* to every tenth or fifth degree of the half circle *ADE* noting in the Equator *AB* every interfection of it and the rule. The like do from the point *B* to the semicircle *CAB* noting also the interfections in the Meridian *CD*. Then the diameters *CB* and *AB* being drawn out at both ends as far as may suffice, finding in the line *DC* the center of the tenth division from *A* to *C* and from *B* to *C*, and of the first point of interfection noted in the Meridian from the Equator to yards *C* by a way familiar to Geometricians: connect the three points, and you have the parallel of ten degrees from
E the

the Equator: the like must be done in drawing the other pa-

if you should cut an apple by the eye and the stalk, or cutting

C

the North Atlantic Ocean, and be-

10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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11. The following table shows the number of people who attended the concert in each age group.

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~~quadrant; the other quadrant is part of the~~

discular line from the point of contact

on it is supposed) must be the same as the height of the water in the well.

that, which will appear crowded, do that. Lay a ruler from the

[illegible]

parallels on either side of the Equator as also in drawing the meridians from centers found in the line AB in like manner con-

runned. All which is illustrated by the following diagram.

the diameter of the hole is 1.5 mm. The diameter of the hole is 1.5 mm.

2. To describe a polar planisphere, draw a circle $ACDB$ on

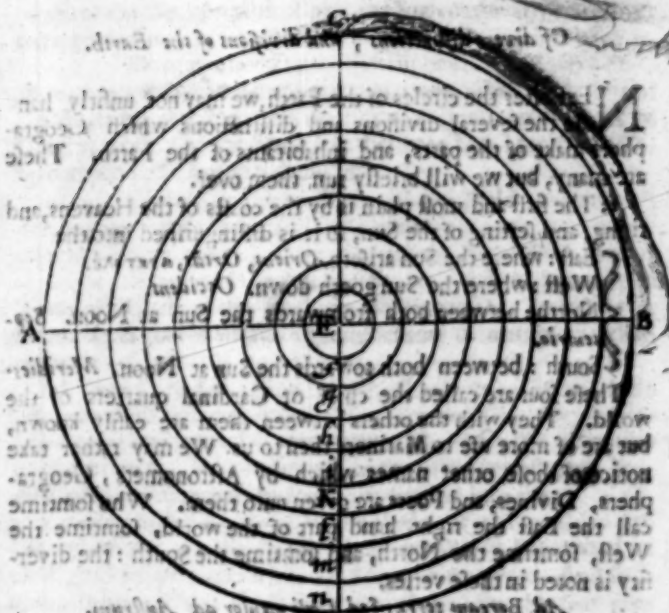
The center E , and as before, inscribe in it two diameters AB and BC cutting each other at right angles, and the circle into

four quadrants. Each quadrant being divided into 90 parts,

And, three points, and you have the parallel of all business firms.

1990

draw from every 5th or 10th of those parts a diameter to the
CHAP. V.



opposite point: these lines all concurring in the center **E** be-
ing the pole, are as so many Meridians. Next, having cut the
half of any one of the former diameters into nine parts, as **ED**,
in the points **FGHIKLMN**, draw on the center **E** so many
circles, and these represent the parallels of the Globe, being
also here true parallels.

The second distinction is by the hot and cold: that are observed on the Earth: this is the divi-
sion of the Earth by Zones or Climates, which are parts of the earth,
near and cold do remain invariable of degrees.

CHAP.

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Of divers distinctions, and divisions of the Earth.

NExt after the circles of the Earth, we may not unfitly handle the several divisions and distinctions which Geographers make of the parts, and inhabitants of the Earth. These are many, but we will briefly run them over.

1. The first and most plain is by the coasts of the Heavens, and rising, and setting of the Sun, so it is distinguished into the

East: where the Sun riseth. *Oriens, Ortus, ἀνατολή.*

West: where the Sun goeth down. *Occident.*

North: between both fromwards the Sun at Noon. *Septentrion.*

South: between both towards the Sun at Noon. *Meridies.*

These four are called the chief or Cardinal quarters of the world. They with the others between them are easily known, but are of more use to Mariners than to us. We may rather take notice of those other names which by Astronomers, Geographers, Divines, and Poets are given unto them. Who sometime call the East the right hand part of the world, sometime the West, sometime the North, and sometime the South: the diversity is noted in these verses.

Ad Boream terra, sed Calimen for ad Austrum.

Præ Dei exortum videt, occasumque Poeta.

That is, Geographers look to the North, Astronomers to the South, Priests turn them to the East, and Poets to the West.

This serves for understanding of Authors, wherein any mention is made of the right or left part of the world. If for example he be a Poet, he means the South by the right hand, the North by the left, because a Poet turns his face to the West, and so reckons the quarters of Heaven and Earth.

2. The second distinction is by the notable differences of heat and cold, that are observed on the Earth: this is the division of the Earth by Zones or Girdles, which are parts of the earth, where heat and cold do remarkably increase or decrease.

Those Zones are Five.

1. The hot or burning Zone (*Zona torrida*) which contains

all that Space of earth, that lieth between the two Tropicks, supposed heretofore (but falsly as after experience hath shewed) to be uninhabitable by reason of heat, the Sun continually lying over some part of it.

2. 3. The temperate Zones wherein neither heat nor cold is extreame but moderate: these are two, one on the North side of the Equator, between the Arctick circle, and the Tropick of Cancer, another on the South side between the Tropick of Capricorn, and the Antarctick circle.

4. 5. The cold or frozen Zones, wherein cold for the most part is greater then the heat; these likewise are two, one in the North, between the Arctick circle, and the North Pole, another on the South, between the Antarctick circle and the South Pole. These of all parts of the Earth are most inhabited, according as extremity of cold is alwaies a greater enemy to mans body, then extremity of heat.

3. The third distinction is by the shadowes which bodies do cast upon the Earth, just at Noon-day; for these do not alwaies fall one way, but diversly, according to their diverse situation upon the Earth. Now in respect of the shadowes of mens bodies, the inhabitants of the Earth are divided into the

1. *Ambrosii* (*ambrosii*) whose shadowes at Noon-day fall both waies, *sc.* to the North when the Sun is Southward of them, and to the South when the Sun is Northward. And such are those People that dwell in the hot Zone. For the Sun goes over their heads twice a year, once Northward, another time Southward. When the Sun is just over their heads they are called *Astii*, *sc.* without shadow.

2. *Hierosii* (*hierosii*) whose shadowes do alwaies fall one way, namely alwaies towards the North: as those that dwell in the Northern temperate Zone, or alwaies to the South, as those that dwell in the Southern temperate Zone.

3. *Perisii* (*perisii*) whose shadowes go round about them: as those people who dwell in the two cold Zones: for as the Sun never goes down to them after he is once up, but alwaies round about, so do their shadowes.

4. The fourth distinction is by the situation of the inhabitants of the Earth, compared one with another, who are called either

1. *Perisii* (*perisii*) such as dwell round about the Earth in one

one and the same parallel, as for example, under the Tropick of Cancer.

2. *Antipodes* (*antipodes*) such as dwell opposite to the former in another parallel of the same distance from the Equator. As those under the Tropick of Capricorn.

3. *Antipodes* (*antipodes*) who dwell just under us, their feet opposite to ours. 5. The first distinction is of the length and breadth of the Earth, and places upon it: these may be considered two waies.

1. Absolutely, and so the Longitude or length of the Earth is its circuit, and Extension from East to West.

Latitude or breadth of it, is the whole circuit and compass of it from North to South.

2. Comparatively, comparing one places situation with another, and so the

Longitude of a place, is the distance of it from the first Meridian going through the Canary Ilands, Eastward. Whereby we know how far one place lies East or West from another.

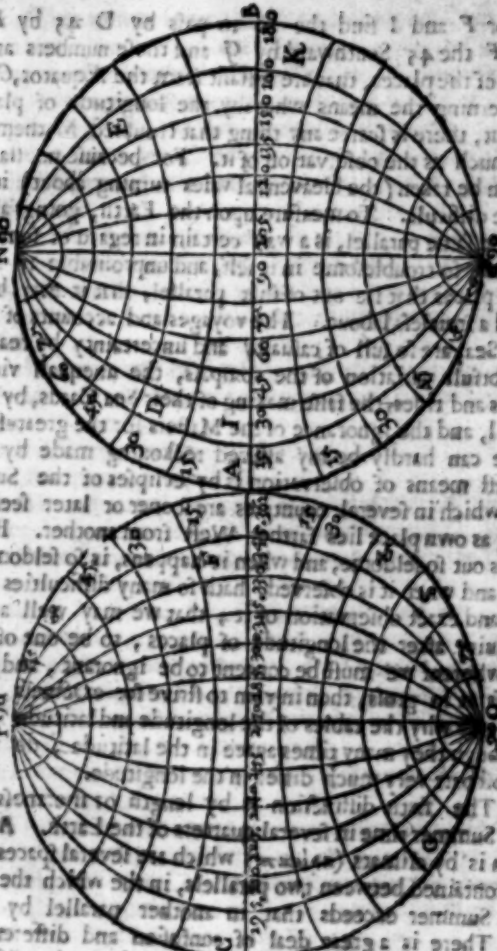
Latitude of a place, is the distance of it from the Equator towards the North or South. Whereby we know how far one place lies Northward, or Southward of another.

The longitude must be reckoned by the degrees of the Equator, the latitude by the degrees of the Meridian.

For example, in these two Hemispheres, the longitude of the whole Earth is from C to A and B in the Equator. The Latitude is from N to S, and from Q to P the North and South Poles, and this reckoned in any Meridian. The first Meridian is ANBS which goes by the Canary Ilands, the Equinoctial is ABCA. Now I have a City given *fe. D* I would know in what Longitude and Latitude it is. For the Longitude I consider what Meridian passeth through it, which is the Meridian *15 NDS* which crosseth the Equinoctial in *12* degrees, wherefore I say that *D* stands Eastward from the first Meridian *15* degrees. So I find that the City *E* is *130* degrees Eastward, *G 105* and *F 345*.

For the Latitude I consider what parallel runs through

and are to be known: I here are 24 Climates, in which the
 to record their opinions and Calculations: thus much is plain
 and diverse reckonings of the Climate: it is not worth the labour
 even the late and ancient Geographers about the distinction
 point. There is a great deal of confusion and difference be-
 day in summer exceeds that in winter, which is not
 half contained between two parallels, in the which the longest
 day in summer is 17 hours (or more), which is the longest
 day in summer, and the shortest day in winter is 7 hours.
 And this is the reason why the longest day in summer is not
 the same in all places, but varies according to the latitude of the
 place. The longest day in summer is 17 hours in the latitude of
 47 degrees, and 18 hours in the latitude of 52 degrees, and 19
 hours in the latitude of 57 degrees, and 20 hours in the latitude
 of 62 degrees, and 21 hours in the latitude of 67 degrees, and 22
 hours in the latitude of 72 degrees, and 23 hours in the latitude
 of 77 degrees, and 24 hours in the latitude of 82 degrees.
 The shortest day in winter is 7 hours in the latitude of 47
 degrees, and 6 hours in the latitude of 52 degrees, and 5 hours
 in the latitude of 57 degrees, and 4 hours in the latitude of 62
 degrees, and 3 hours in the latitude of 67 degrees, and 2 hours
 in the latitude of 72 degrees, and 1 hour in the latitude of 77
 degrees, and 0 hours in the latitude of 82 degrees.
 The middle day in summer is 12 hours in the latitude of 47
 degrees, and 13 hours in the latitude of 52 degrees, and 14
 hours in the latitude of 57 degrees, and 15 hours in the latitude
 of 62 degrees, and 16 hours in the latitude of 67 degrees, and 17
 hours in the latitude of 72 degrees, and 18 hours in the latitude
 of 77 degrees, and 19 hours in the latitude of 82 degrees.
 The middle day in winter is 12 hours in the latitude of 47
 degrees, and 11 hours in the latitude of 52 degrees, and 10
 hours in the latitude of 57 degrees, and 9 hours in the latitude
 of 62 degrees, and 8 hours in the latitude of 67 degrees, and 7
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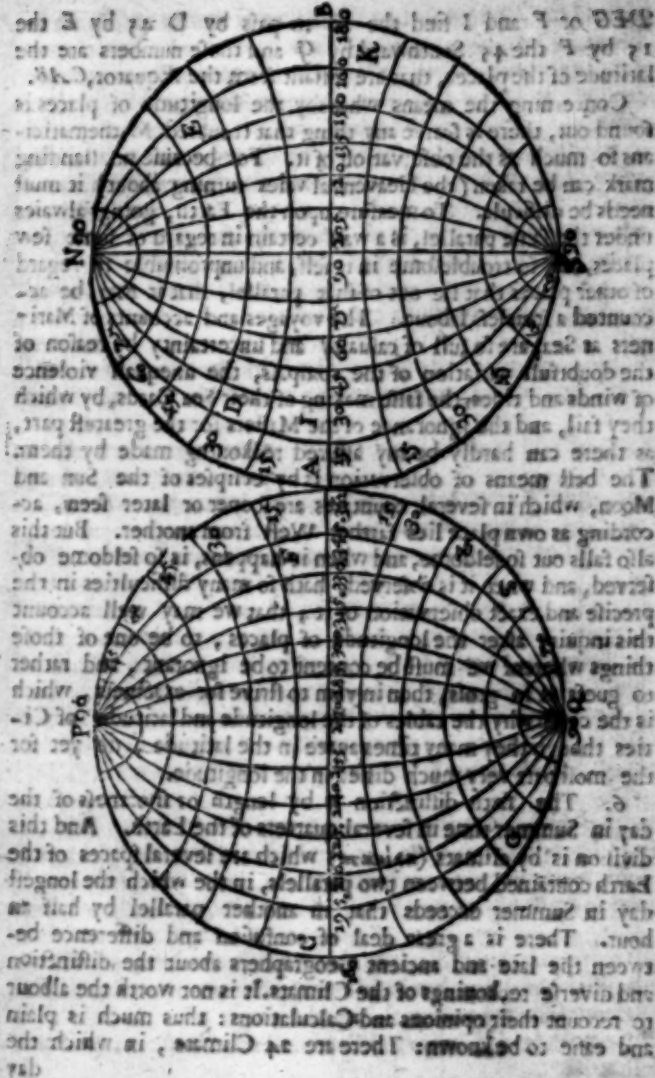
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Latitude of a place, is the distance of it from the Equator towards the North or South. Whereby we know how far one place lies Northward, or Southward of another.

The longitude must be reckoned by the degrees of the Equator, the latitude by the degrees of the Meridian.

For example, in these two Hemispheres, the longitude of the whole Earth is from C to A and B in the Equator. The latitude is from N to S, and from Q to R the North and South Poles, and this reckoned in any Meridian. The first Meridian is *ANBS* which goes by the Canary Ilands, the Equinoctial is *ABCA*. Now I have a City given *for D* I would know in what Longitude and Latitude it is. For the Longitude I consider what Meridian passeth through it, which is the Meridian *15 NBS* which crosseth the Equinoctial in *C* at 15 degrees, wherefore I say that *D* stands Eastward from the first Meridian 15 degrees. So I find that the City *E* is 130 degrees Eastward, *G* 95 and *F* 345.

For the Latitude I consider what parallel runs through



INTRODUCTION

THE *or* *P* and *I* find the 10 to pass by *D* 45 by *E* the 45 by *P* the 45 Southward by *G* and those numbers are the latitude of the places, that are distant from the Equator, *CAB*.

Concerning the means whereby the longitude of places is found out, there is scarce any thing that troubled Mathematicians so much as the observation of it. For because no standing mark can be taken (the Heavens alwaies turning about) it must needs be difficult. To measure upon the Earth, going alwaies under the same parallel, is a way certain in regard of some few places, but so troublesome in it self, and unprofitable in regard of other places that lie out of that parallel, that it may be accounted a fruitless labour. The voyages and accounts of Mariners at Sea, are so full of casualty and uncertainty by reason of the doubtfull variation of the compass, the unequal violence of winds and tides, the false making of their Sea Cards, by which they fail, and the ignorance of the Masters for the greatest part, as there can hardly be any assured reckoning made by them. The best means of observation is by eclipses of the Sun and Moon, which in several countries are sooner or later seen, according as own place lies farther West from another. But this also falls out so seldome, and when it happens, is so seldome observed, and when it is observed, hath so many difficulties in the precise and exact observation of it, that we may well account this inquiry after the longitude of places, to be one of those things whereof we must be content to be ignorant, and rather to guess at in gross, then in vain to strive for exactness, which is the cause why the tables of the longitude and latitude of Cities though they many times agree in the latitude, do yet for the most part very much differ in the longitude.

6. The sixth distinction is by length or shortness of the day in Summer time in several quarters of the Earth. And this division is by *climates* (*climates*) which are several spaces of the Earth contained between two parallels, in the which the longest day in Summer exceeds that in another parallel by half an hour. There is a great deal of confusion and difference between the late and ancient Geographers about the distinction and diverse reckonings of the *Climates*. It is not worth the labour to recount their opinions and Calculations: thus much is plain and easie to be known: There are 24 *Climates*, in which the day

day increaseth by half hours, from 12 hours in the Equinoctial, likewise six Climats in which the day is longer than 12 hours, from one month to six, that is half a year. Thus the day is longer for the day is alwayes twelve hours long, but as you go from it towards the Pole, the day lengthens till it comes to a day, half a year long. Now in what degrees of Latitude every one of these Climats begins and ends, shall appear in the Table following.

The use of this Table is easie. In the first Column are contained the names and number of the Climats. In the second the Parallels which enlose it on each side, and divide it in the midst. For the parallels here are drawn by every 2 hours increase.

The third Column is the length of the day in Summer, in every Climate, which from 12 houres encreaseth by half hours to 24 hours, after by months, from one month to six.

The fourth contains the degrees of Latitude, how far every Climate lies from the Equinoctial.

The fifth contains the space or breadth of every Climate how many degrees, or minutes it takes up upon the earth.

The sixth contains some notable places by which the Climats pass.

Hereby it is easy to know what the longest day is in any place of the world whose Longitude is known. Or conversely the longest day being known to know the Latitude. For example, *Oxford* hath Latitude 52.0. degrees, Longitude 22.0. In the Table I find that 52 degrees of Latitude, lie in the ninth Climate wherein the day is 16 houres and a half long, so much I say the day is at *Oxford* in Summer. The place of *Oxford* in the hemisphere is at 4.

Upon Globes the Climates are not usually described, but are noted out upon the brazen Meridian. So also in universal Maps they are seldome drawn, to avoid confusion of many lines together, but they are many times marked out on the limb or edge of the Map.

The seventh and last distinction of the Earth is taken from the situation of it in respect of the Heavens, and especially the Suns motion. In regard whereof some parts or inhabitants of the Earth, are said to be, or dwell in a right Sphere, some in a

These that dwell under the pole have the pole over or under them, and therefore have day or night continually. As for example, the North Pole is continually day, and the South Pole is continually night. The Climates that lie between the pole and the Equinoctial, have day and night continually, but the day is longer than the night, and the night is longer than the day, according to the distance of the place from the Equinoctial. The Climates that lie between the Equinoctial and the Tropic of Cancer, have day and night continually, but the day is longer than the night, and the night is longer than the day, according to the distance of the place from the Equinoctial. The Climates that lie between the Tropic of Cancer and the Tropic of Capricorn, have day and night continually, but the day is longer than the night, and the night is longer than the day, according to the distance of the place from the Equinoctial. The Climates that lie between the Tropic of Capricorn and the Tropic of Aquarius, have day and night continually, but the day is longer than the night, and the night is longer than the day, according to the distance of the place from the Equinoctial. The Climates that lie between the Tropic of Aquarius and the Tropic of Cancer, have day and night continually, but the day is longer than the night, and the night is longer than the day, according to the distance of the place from the Equinoctial. The Climates that lie between the Tropic of Cancer and the Tropic of Capricorn, have day and night continually, but the day is longer than the night, and the night is longer than the day, according to the distance of the place from the Equinoctial. The Climates that lie between the Tropic of Capricorn and the Tropic of Aquarius, have day and night continually, but the day is longer than the night, and the night is longer than the day, according to the distance of the place from the Equinoctial. The Climates that lie between the Tropic of Aquarius and the Tropic of Cancer, have day and night continually, but the day is longer than the night, and the night is longer than the day, according to the distance of the place from the Equinoctial.

A Brief INTRODUCTION

parallel sphere, and others in an oblique or crooked sphere.

They dwell (in *Sphæra recta*) in a right or straight sphere, who dwell just under the *Æquinoctial*, whose Horizon is parallel to the Meridians, but cuts the *Æquator* at right Angles.

They dwell in parallel spheres, who dwell just under either of the poles, whose Horizon is parallel to the *Æquator*, but cuts all the Meridians at right Angles: and the latter is sometime called a parallel sphere.

They dwell (in *Sphæra obliqua*) in a crooked sphere, who inhabit any place between the *Æquinoctial* and the pole, whose Horizon cuts the *Æquator*, the parallels, and the Meridians at oblique or unequal Angles.

CHAP. VI.

Of the measuring of the Earth.

WE are now come to the last point concerning the measuring of the Earth, which is two-fold,

1. Whole earth.

Either of the 2. Several parts thereof, and their distance one from another.

Concerning the first it is but a needless labour to recount the diversity of opinions that have been held from time to time by learned Geographers, what is the compass and depth of the Earth. This may be seen in *Hues de usu Globi*, part. 3. cap. 2 &c. in *Clavius* on *Sacrobosco* with others. They all differ so much one from another, that there is no certainty in stuffing any of them. The most common and received opinion is, that the circuit of the earth is 31600 miles, reckoning 60 miles for every degree, and then the depth or Diameter of the Earth shall be 6877 English miles, containing 5000 foot in a mile.

The means whereby the circuit and Diameter of the Earth are found out are principally two.

1. By measuring North or South, under one Meridian some good quantity of ground, threescore or an hundred miles (or two for the more certainty) for in those petty observations of

small

small distances there can be no certain working. This may be done, though it be laborious, yet exactly without any sensible error dy a skilful workman, plotting it but upon his paper, with due heed taken that he often rectifie the variation of the needly (by which he travels) upon due observations, and that all notable ascents and descents, with such winding and turning as the necessity of the way causeth, be reduced to one straight line. By this meanes we shall know how many miles in the Earth answereth to a degree in the Heavens; if exact observation by large Instruments be made to find the elevation of the Pole, in the first place where we begin to measure, and the last where we make an end.

Besides this way of measuring the circumference of the Earth, there is none other that hath any certainty of observation in it. That by Eclipses is most uncertain, for a little error in a few minutes of time (which the observers shall not possibly avoid) breeds a sensible and foul error in the distance of the two places of observation. That of *Eratosthenes* by the Sun Beames, and a shadow of a stile or gnomon set upon the Earth, is as bad as the other. For both the uncertainty of the calculation is so small quantity as the shadow and the gnomon must needs have, and the difficulty to observe the true length of the shadow, as also the false supposition whereupon it proceeds, selling those lines for parallels which are not, do manifestly shew the reckoning hereby made to be doubtfull and not sure.

2. The second is by measuring the semidiameter of the Earth: For as the circumference makes known the diameter, so doth this the circumference. This may be done by observation made upon some great hill, hard by the Sea side. The inventions of *Maurelycus Abbot of Messana in Sicilia*, but it hath been perfected, and more exactly performed by a worthy Mathematician *Ed. W.* who himself made proof of it. By this art was the semidiameter of the Earth found out to be 18312621 foot, which allowing 5003 foot to a mile is 3662 and a half miles, which doubled is the whole diameter 7324 miles. The circuit of the earth shall be 23030 miles, and one degree contains $63\frac{63}{36}$ miles,

which is almost 64 miles, which as it exceeds the ordinary account, so may we rest upon it as more exact then any other.

2. The second point concerning the measuring of particular distances of places one from another is thus performed.

First upon the Globe it is most easie. With a pair of Compasses take the distance between any two places howsoever situated upon the Globe, and apply the distance so taken to the Equator, and see how many degrees it takes up; those degrees turned into miles shew the distance of the two Cities one from another.

Upon universal Maps there is a little more difficulty in finding the distance of places, which here must be considered in a three-fold method of situation.

1. Of Latitude only.

2. Of Longitude only.

3. Of Latitude and Longitude together.

1. If the two places differ only in Latitude, and lie under the same Meridian, if the places lie both on one side of the Equator, the difference of the Latitudes, or the sum of both Latitudes added together, if one place lie North and another South, being turned into miles gives the true distance.

2. If the places differ only in Longitude, and lie both under one parallel of Latitude, the difference of Longitude turned into miles proportionably according to the Latitude of the parallel, gives the true distance.

3. The distance of places differing both in Latitude and Longitude may thus be found out, first let there be drawn a semicircle upon a right diameter noted with $A B C D$ whereof D shall be the center. The greater this semicircle is made, so much the more easie will be the operation; because the degrees will be larger. Then this semicircle being drawn and accordingly divided, imagine that by the help of it, you desire to find out the distance betwixt *London* and *Jerusalem*, which Cities are known to differ both in Longitude and Latitude. Now that the true distance betwixt these two places may be found out, you must first subtract the lesser Longitude out of a greater, so shall you find the differences of their Longitudes, which is 47 degrees. Then reckon that difference upon the semicircle, beginning at A and so proceed to B ; and at the end of that difference, make a mark with the letter E unto which point by your ruler let a right line be drawn from D the center of the semicircle.

micircle. This being in this sort performed, let the lesser Latitude be sought out, which is 32 degrees, in the aforesaid semicircle, beginning your account from the point *E* and so proceed towards *B*, and at the end of the lesser Latitude let another point be marked out with the letter *G*, from which point let there be drawn a perpendicular line which may fall with right angles upon the former line drawn down *D* to *E*, and where it chanceth to fall, there mark out a point with the letter *H*: This being performed let the greater Latitude which is 51 degrees 51 minutes, be sought out in the semicircle beginning to reckon from *A* towards *B*, and at the end of that Latitude set another point signed out by the letter *I*, from whence let there be drawn another perpendicular line that may fall with right angles upon the diameter *AC*: and here mark out a point with the letter *K*: this done take with your compass the distance betwixt *K* and *H* which distance you must set down upon the diameter *AC* placing the one foot of your compass upon *K* and the other towards the center *D*, and there mark out a point with the letter *L*; then with your compass take the shorter perpendicular line *GH*, and apply that wideness upon the longer perpendicular line *IK*, placing the one foot of your compass at *I*, which is the bounds of the greater Latitude, and extend the other towards *K*, and there take a point at *M*, then with your compass take the distance betwixt *L* and *M*, and apply the same to the semicircle, placing the one foot of your compass in *A* and the other towards *B*, and there mark out a point with the letter *N*: now the number of degrees comprehended betwixt *A* and *N* will express the true distance of the two places, which will be found to be 39 degrees: which being multiplied by 60 and so converted into miles according to the former rules, will produce 2340 which is the distance of the said places.

FINIS.